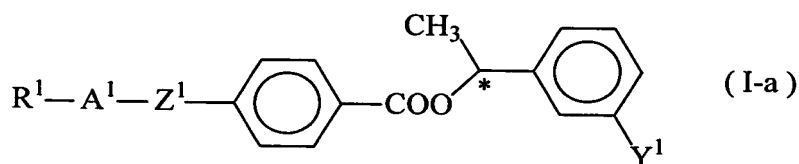


What is claimed is:

1. A chiral nematic liquid crystal composition comprising:

at least one optically active compound represented by general formula (I-a):



5 wherein * indicates a position of an asymmetric carbon atom;

R¹ represents an alkyl group having 1 to 10 carbon atoms, an alkenyl group having 2 to 10 carbon atoms, a fluorine atom, a chlorine atom, a bromine atom, an iodine atom, a cyano group, or an isothiocyanate group, said alkyl group or said alkenyl group being either unsubstituted or substituted with at least one fluorine atom, chlorine atom, cyano group, methyl group or trifluoromethyl group, and at least one methylene group within
10 said alkyl group or said alkenyl group may be substituted with either -CO- group, or with oxygen atom or -COO- group, provided oxygen atoms are not bonded together directly;

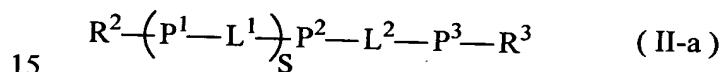
A¹ represents a 1,4-phenylene group, 1,4-cyclohexylene group, 1,4-cyclohexenylene group, tetrahydropyran-2,5-diyl group, 1,3-dioxane-2,5-diyl group, tetrahydrothiopyran-2,5-diyl group, 1,4-bicyclo[2,2,2]octylene group, decahydronaphthalene-2,6-diyl group, pyridine-2,5-diyl group, pyrimidine-2,5-diyl group, pyrazine-2,5-diyl group, 1,2,3,4-tetrahydronaphthalene-2,6-diyl group, 2,6-naphthylene group, phenanthrene-2,7-diyl group, 9,10-dihydrophenanthrene-2,7-diyl group, 1,2,3,4,4a,9,10a-octahydrophenanthrene-2,7-diyl group, or fluorene-2,7-diyl group, and
15 said 1,4-phenylene group, 1,2,3,4-tetrahydronaphthalene-2,6-diyl group, 2,6-naphthylene group, phenanthrene-2,7-diyl group, 9,10-dihydrophenanthrene-2,7-diyl group, 1,2,3,4,4a,9,10a-octahydrophenanthrene-2,7-diyl group, or fluorene-2,7-diyl group is
20 either unsubstituted or is substituted with at least one fluorine atom, chlorine atom,

trifluoromethyl group, trifluoromethoxy group, or methyl group;

Z^1 represents a single bond, or $-\text{CO}-$, $-\text{COO}-$, $-\text{OCO}-$, $-\text{CH}=\text{N}-$, $-\text{N}=\text{CH}-$, $-\text{C}\equiv\text{C}-$, $-\text{CH}_2\text{CH}_2-$, $-\text{CH}_2\text{CH}_2\text{CH}_2-$, $-\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2-$, $-\text{CH}_2\text{O}-$, $-\text{OCH}_2-$, $-\text{CF}_2\text{O}-$, $-\text{OCF}_2-$, $-\text{CH}=\text{N}-\text{N}=\text{CH}-$, $-\text{CF}=\text{CF}-$, $-\text{CH}=\text{CH}-$, $-\text{CH}_2\text{CH}_2\text{CH}=\text{CH}-$, $-\text{CH}=\text{CHCH}_2\text{CH}_2-$, or $-\text{CH}_2\text{CH}=\text{CHCH}_2-$; and

Y^1 represents a hydrogen atom, an alkyl group having 1 to 10 carbon atoms, an alkenyl group having 2 to 10 carbon atoms, a fluorine atom, a chlorine atom, a bromine atom, an iodine atom, a cyano group, or an isothiocyanate group, said alkyl group or said alkenyl group being either unsubstituted or substituted with at least one fluorine atom, chlorine atom, cyano group, methyl group or trifluoromethyl group, and at least one methylene group within said alkyl group or said alkenyl group may be substituted with either $-\text{CO}-$ groups, or with oxygen atoms or $-\text{COO}-$ groups provided oxygen atoms are not bonded together directly, and

at least one optically active compound represented by general formula (II-a):



wherein R^2 and R^3 each independently represent a hydrogen atom, a fluorine atom, a chlorine atom, a bromine atom, an iodine atom, a cyano group, a phenyl group, an alkyl group having 1 to 10 carbon atoms, or an alkenyl group having 2 to 10 carbon atoms, said alkyl group or said alkenyl group being either unsubstituted or substituted with at least one fluorine atom, chlorine atom, cyano group, methyl group or trifluoromethyl group, and at least one methylene group within said alkyl group or said alkenyl group may be substituted with either $-\text{CO}-$ group, or with oxygen atom or $-\text{COO}-$ group, provided oxygen atoms are not bonded together directly;

The meaning of each of P^1 and P^2 independently is the same as that of said group A^1 in

general formula (I-a);

The meaning of P^3 is the same as that of said group A^1 in general formula (I-a), or P^3 represents a 1,3-phenylene group, and said 1,3-phenylene group is either unsubstituted or is substituted with at least one fluorine atom, chlorine atom, trifluoromethyl group,

5 trifluoromethoxy group, or methyl group;

L^1 and L^2 each independently represent a single bond, or $-CO-$, $-COO-$, $-OCO-$, $-C\equiv C-$, $-CH_2CH_2-$, $-CH_2CH_2CH_2-$, $-CH_2CH_2CH_2CH_2-$, $-CH_2COO-$, $-CH_2OCO-$, $-CH_2O-$, $-OCH_2-$, $-CF_2O-$, $-OCF_2-$, $-CH=N-N=CH-$, $-CF=CF-$, $-CH=CH-$, $-CH_2CH_2CH=CH-$, $-CH=CHCH_2CH_2-$, $-CH_2CH=CHCH_2-$, or $-COOCH_2CH_2OCO-$, and a hydrogen atom of

10 a C-H linkage in $-CH_2CH_2-$, $-CH_2CH_2CH_2-$, $-CH_2CH_2CH_2CH_2-$, $-CH_2COO-$, $-CH_2OCO-$, $-CH_2O-$, $-CH_2CH_2CH=CH-$, $-CH=CHCH_2CH_2-$, or $-COOCH_2CH_2OCO-$ may be substituted with an alkyl group having 1 to 5 carbon atoms in which at least one hydrogen atom in said alkyl group may be substituted with a fluorine atom, or a phenyl group; and

15 s represents 0, 1, or 2, and in a case in which $s=2$, a plurality of P^1 and L^1 groups represent either identical groups or different groups, although at least one of R^2 , R^3 , L^1 and L^2 must be an optically active group, with an identical helical twisting direction to said compound represented by general formula (I-a), a helical twisting power; HTP in $1/\mu m$, as represented by a formula shown below,

20
$$HTP = 1/(P \times 0.01C)$$

wherein C represents an amount of added optically active compound in weight %, and P represents a natural pitch in μm of at least 3, and a natural pitch which is induced upon addition to a nematic liquid crystal increases with increasing temperature.

2. A chiral nematic liquid crystal composition according to claim 1, wherein in general formula (I-a):

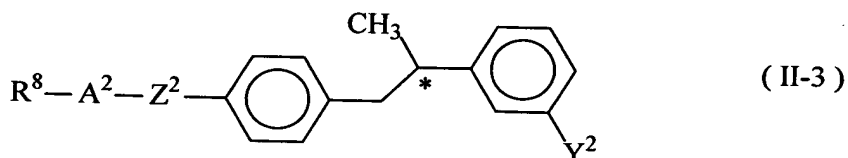
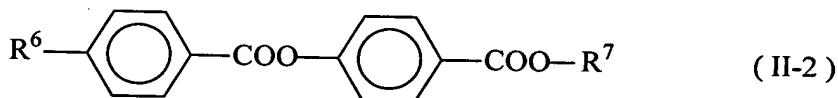
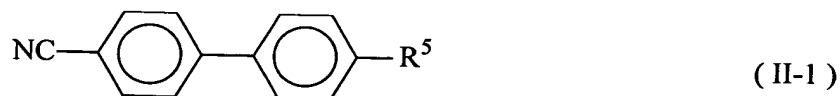
R¹ represents an alkyl group having 1 to 10 carbon atoms or an alkenyl group having 2 to 10 carbon atoms, said alkyl group or said alkenyl group being either unsubstituted or substituted with at least one fluorine atom, trifluoromethyl group, or methyl group, and at least one methylene group within said alkyl group or said alkenyl group may be substituted with either -CO- group, or with oxygen atom or -COO- group, provided oxygen atoms are not bonded together directly,

A¹ represents a 1,4-phenylene group or a 1,4-cyclohexylene group,

10 Z¹ represents a single bond, or -COO-, -OCO-, -C≡C-, or -CH₂CH₂-, and

Y¹ represents a hydrogen atom, a fluorine atom, a chlorine atom, a bromine atom, an iodine atom, an alkyl group having 1 to 3 carbon atoms, or an alkenyl group having 2 to 3 carbon atoms, said alkyl group or said alkenyl group being either unsubstituted or substituted with at least one fluorine atom, and at least one methylene group within said alkyl group or said alkenyl group may be substituted with either -CO- group, or with oxygen atom or -COO- group, provided oxygen atoms are not bonded together directly.

3. A chiral nematic liquid crystal composition according to claim 1, comprising at least one compound selected from a group consisting of compound represented by general formula (II-1), general formula (II-2) and general formula (II-3):



wherein R^5 represents an alkyl group having 1 to 10 carbon atoms or an alkenyl group having 2 to 10 carbon atoms, said alkyl group or said alkenyl group being either unsubstituted or substituted with at least one fluorine atom, chlorine atom, trifluoromethyl group or methyl group, at least one methylene group within said alkyl group or said alkenyl group may be substituted with either -CO- group, or with oxygen atom or -COO- group, provided oxygen atoms are not bonded together directly, and said alkyl group or said alkenyl group has at least one asymmetric carbon atom;

R^6 and R^7 each independently represent a fluorine atom, a chlorine atom, a bromine atom, an iodine atom, a cyano group, an alkyl group having 1 to 10 carbon atoms, or an alkenyl group having 2 to 10 carbon atoms, said alkyl group or said alkenyl group being either unsubstituted or substituted with at least one fluorine atom, chlorine atom, trifluoromethyl group or methyl group, at least one methylene group within said alkyl group or said alkenyl group may be substituted with either -CO- group, or with oxygen atom or -COO- group, provided oxygen atoms are not bonded together directly, and at least one of R^6 and R^7 contains at least one asymmetric carbon atom;

* represents a position of an asymmetric carbon atom;

R^8 represents a fluorine atom, a chlorine atom, a bromine atom, an iodine atom, a cyano group, an alkyl group having 1 to 10 carbon atoms, or an alkenyl group having 2 to 10

carbon atoms, said alkyl group or said alkenyl group being either unsubstituted or substituted with at least one fluorine atom, chlorine atom, trifluoromethyl group or methyl group, and at least one methylene group within said alkyl group or said alkenyl group may be substituted with either -CO- group, or with oxygen atom or -COO- group, provided oxygen atoms are not bonded together directly;

Z^2 represents a single bond, or -CO-, -COO-, -OCO-, -CH=N, -N=CH-, -C≡C-, -CH₂CH₂-, -CH₂CH₂CH₂-, -CH₂CH₂CH₂CH₂-, -CH₂O-, -OCH₂-, -CF₂O-, -OCF₂-, -CH=N-N=CH-, -CF=CF-, -CH=CH-, -CH₂CH₂CH=CH-, -CH=CHCH₂CH₂-, or -CH₂CH=CHCH₂-;

A^2 represents a 1,4-phenylene group, 1,4-cyclohexylene group, 1,4-cyclohexenylene group, tetrahydropyran-2,5-diyl group, 1,3-dioxane-2,5-diyl group, tetrahydrothiopyran-2,5-diyl group, 1,4-bicyclo[2,2,2]octylene group, decahydronaphthalene-2,6-diyl group, pyridine-2,5-diyl group, pyrimidine-2,5-diyl group, pyrazine-2,5-diyl group, 1,2,3,4-tetrahydronaphthalene-2,6-diyl group, 2,6-naphthylene group, phenanthrene-2,7-diyl group, 9,10-dihydrophenanthrene-2,7-diyl group, 1,2,3,4,4a,9,10a-octahydrophenanthrene-2,7-diyl group, or fluorene-2,7-diyl group, and said 1,4-phenylene group, 1,2,3,4-tetrahydronaphthalene-2,6-diyl group, 2,6-naphthylene group, phenanthrene-2,7-diyl group, 9,10-dihydrophenanthrene-2,7-diyl group, 1,2,3,4,4a,9,10a-octahydrophenanthrene-2,7-diyl group, or fluorene-2,7-diyl group is either unsubstituted or is substituted with at least one fluorine atom, chlorine atom, trifluoromethyl group, trifluoromethoxy group, or methyl group; and

Y^2 represents a hydrogen atom, an alkyl group having 1 to 3 carbon atoms, an alkenyl group having 2 to 3 carbon atoms, a fluorine atom, a chlorine atom, a bromine atom, or an iodine atom, said alkyl group or said alkenyl group being either unsubstituted or substituted with at least one fluorine atom, chlorine atom, trifluoromethyl group, cyano

group or methyl group, and at least one methylene group within said alkyl group or said alkenyl group may be substituted with either -CO- group, or with oxygen atom or -COO- group, provided oxygen atoms are not bonded together directly.

5 4. A chiral nematic liquid crystal composition according to claim 3, wherein in general formula (I-a):

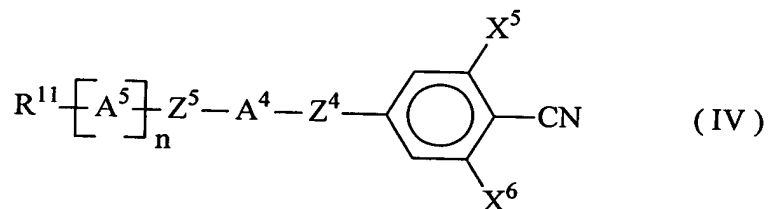
R^1 represents an alkyl group having 1 to 10 carbon atoms or an alkenyl group having 2 to 10 carbon atoms, said alkyl group or said alkenyl group being either unsubstituted or substituted with at least one fluorine atom, trifluoromethyl group, or methyl group, and at
10 least one methylene group within said alkyl group or said alkenyl group may be substituted with either -CO- group, or with oxygen atom or -COO- group, provided oxygen atoms are not bonded together directly,

A^1 represents a 1,4-phenylene group or a 1,4-cyclohexylene group,

Z^1 represents a single bond, or -COO-, -OCO-, $-C\equiv C-$, or $-CH_2CH_2-$, and

15 Y^1 represents a hydrogen atom, a fluorine atom, a chlorine atom, a bromine atom, an iodine atom, an alkyl group having 1 to 3 carbon atoms, or an alkenyl group having 2 to 3 carbon atoms, said alkyl group or said alkenyl group being either unsubstituted or substituted with at least one fluorine atom, and at least one methylene group within said alkyl group or said alkenyl group may be substituted with either -CO- group, or with
20 oxygen atom or -COO- group, provided oxygen atoms are not bonded together directly.

5. A chiral nematic liquid crystal composition according to claim 1, comprising at least one compound represented by general formula (IV):



wherein R^{11} represents an alkyl group having 1 to 10 carbon atoms, or an alkenyl group having 2 to 10 carbon atoms, said alkyl group or said alkenyl group being either unsubstituted or substituted with at least one fluorine atom, chlorine atom, trifluoromethyl group, cyano group or methyl group, and at least one methylene group within said alkyl group or said alkenyl group may be substituted with either -CO- group, or with oxygen atom or -COO- group, provided oxygen atoms are not bonded together directly;

Z^4 and Z^5 each independently represent a single bond, or -CO-, -COO-, -OCO-, -CH=N-, -N=CH-, -C≡C-, -CH₂CH₂-, -CH₂CH₂CH₂-, -CH₂CH₂CH₂CH₂-, -CH₂O-, -OCH₂-, -CF₂O-, -OCF₂-, -CH=N-N=CH-, -CF=CF-, -CH=CH-, -CH₂CH₂CH=CH-, -CH=CHCH₂CH₂-, or -CH₂CH=CHCH₂-;

A^4 and A^5 each independently represent a 1,4-phenylene group, a 1,4-cyclohexylene group or a pyrimidine-2,5-diyl group, and said 1,4-phenylene group is either unsubstituted or is substituted with at least one fluorine atom, chlorine atom, trifluoromethyl group, trifluoromethoxy group or methyl group;

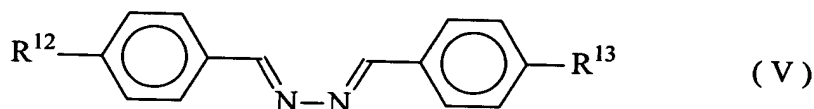
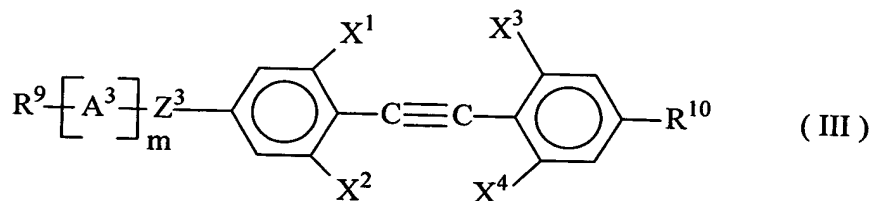
X^5 and X^6 each independently represent a hydrogen atom, a fluorine atom or a chlorine atom; and

n represents either 0 or 1.

20

6. A chiral nematic liquid crystal composition according to claim 1, comprising at least one compound selected from a group consisting of compounds represented by

general formula (III) and general formula (V):



wherein R^9 , R^{10} , R^{12} and R^{13} each independently represent an alkyl group having 1 to 10 carbon atoms, or an alkenyl group having 2 to 10 carbon atoms, said alkyl group or said alkenyl group being either unsubstituted or substituted with at least one fluorine atom, chlorine atom, trifluoromethyl group or methyl group, and at least one methylene group within said alkyl group or said alkenyl group may be substituted with either -CO- group, or with oxygen atom or -COO- group, provided oxygen atoms are not bonded together directly;

Z^3 represents a single bond, or -CO-, -COO-, -OCO-, -CH=N-, -N=CH-, -C≡C-, -CH₂CH₂-, -CH₂CH₂CH₂-, -CH₂CH₂CH₂CH₂-, -CH₂O-, -OCH₂-, -CF₂O-, -OCF₂-, -CH=N-N=CH-, -CF=CF-, -CH=CH-, -CH₂CH₂CH=CH-, -CH=CHCH₂CH₂-, or -CH₂CH=CHCH₂-;

A^3 represents a 1,4-phenylene group or a 1,4-cyclohexylene group, and said 1,4-phenylene group is either unsubstituted or is substituted with at least one fluorine atom, chlorine atom, trifluoromethyl group, trifluoromethoxy group or methyl group;

X^1 , X^2 , X^3 and X^4 each independently represent a hydrogen atom, a fluorine atom, a chlorine atom or a methyl group; and

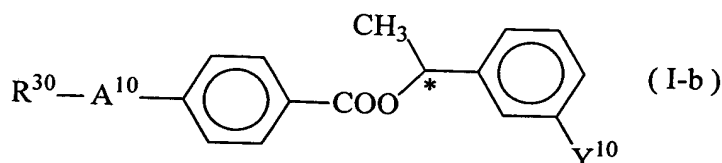
m represents either 0 or 1.

7. A chiral nematic liquid crystal composition according to claim 2, wherein a compound represented by general formula (I-a) comprises 3 to 20% by weight, and a group of compounds represented by general formula (II-1), general formula (II-2) and general formula (II-3) comprises 3 to 30% by weight, and a natural pitch at 25°C is within a range from 0.1 to 3 μm .

8. A chiral nematic liquid crystal composition according to claim 5, wherein a compound represented by general formula (I-a) comprises 3 to 20% by weight, a group of compounds represented by general formula (II-1), general formula (II-2) and general formula (II-3) comprises 3 to 30% by weight, and a compound represented by general formula (IV) comprises 0 to 65% by weight, and a natural pitch at 25°C is within a range from 0.1 to 3 μm .

9. A chiral nematic liquid crystal composition according to claim 6, wherein a compound represented by general formula (I-a) comprises 3 to 20% by weight, a group of compounds represented by general formula (II-1), general formula (II-2) and general formula (II-3) comprises 3 to 30% by weight, and a group of compounds represented by general formula (III) and general formula (V) comprises 5 to 60% by weight, and a natural pitch at 25°C is within a range from 0.1 to 3 μm .

10. A chiral nematic liquid crystal composition according to claim 1 comprising:
from 5 to 15% by weight of at least one optically active compound represented by general formula (I-b):



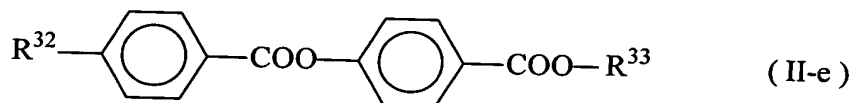
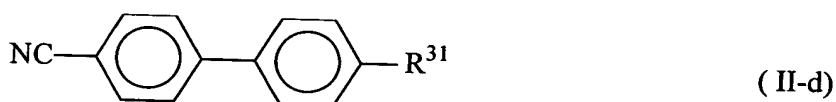
wherein R^{30} represents an alkyl group having 1 to 10 carbon atoms or an alkenyl group having 2 to 10 carbon atoms, said alkyl group or said alkenyl group being either unsubstituted or substituted at least one fluorine atom, trifluoromethyl group, or methyl, and at least one methylene group within said alkyl group or said alkenyl group may be substituted with either -CO- group, or with oxygen atom or -COO- group, provided oxygen atoms are not bonded together directly;

* represents a position of an asymmetric carbon atom;

A^{10} represents a 1,4-phenylene group or a 1,4-cyclohexylene group; and

Y^{10} represents a hydrogen atom, a trifluoromethyl group, a trifluoromethoxy group, a methoxy group, or a methyl group,

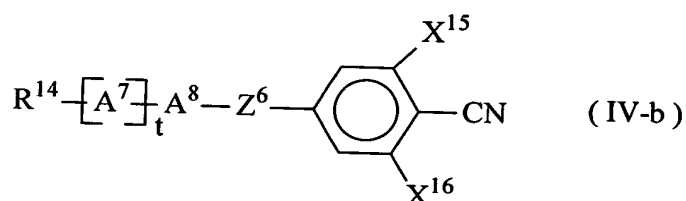
from 3 to 15% by weight of at least one compound selected from a group consisting of optically active compound represented by general formula (II-d) and general formula (II-e):



(wherein R^{31} , R^{32} and R^{33} each independently represent an alkyl group having 1 to 10 carbon atoms or an alkenyl group having 2 to 10 carbon atoms, said alkyl group or said alkenyl group being either unsubstituted or substituted with at least one fluorine atom, trifluoromethyl group, or methyl group, although R^{31} and R^{33} must have at least one asymmetric carbon atom, and at least one methylene group within said alkyl group or

said alkenyl group may be substituted with either -CO- group, or with oxygen atom or -COO- group, provided oxygen atoms are not bonded together directly, with an identical helical twisting direction to said compound represented by general formula (I-b), and for which a natural pitch that is induced upon addition to a nematic liquid crystal increases with rising temperature, and

from 20 to 50% by weight of at least one compound represented by general formula (IV-b):



wherein R^{14} represents an alkyl group having 1 to 10 carbon atoms or an alkenyl group having 2 to 10 carbon atoms, and at least one methylene group within said alkyl group or said alkenyl group may be substituted with oxygen atoms, provided oxygen atoms are not bonded together directly;

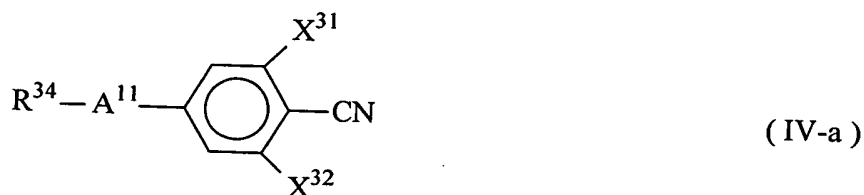
A^7 and A^8 each independently represents a 1,4-phenylene group, a 1,4-cyclohexylene group or a pyrimidine-2,5-diyl group, and said 1,4-phenylene group is either unsubstituted or is substituted with at least one fluorine atom or chlorine atom;

Z^6 represents a single bond, -COO- or -CH₂CH₂-;

X^{15} and X^{16} each independently represent a hydrogen atom, a fluorine atom, or a chlorine atom; and

t represents either 0 or 1, although if $t=0$ then Z^6 represents a single bond.

11. A chiral nematic liquid crystal composition according to claim 10, comprising a compound represented by general formula (IV-a):

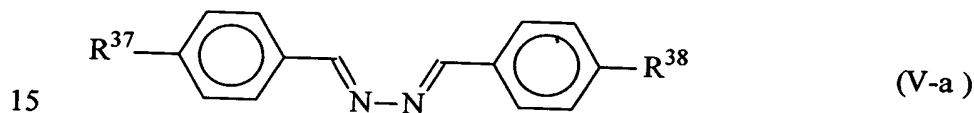
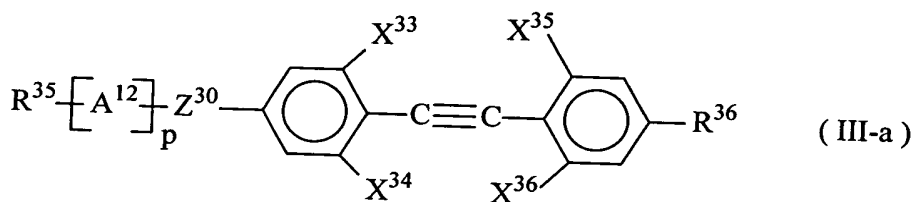


wherein R^{34} represents an alkyl group having 1 to 10 carbon atoms or an alkenyl group having 2 to 10 carbon atoms, and at least one methylene group within said alkyl group or said alkenyl group may be substituted with oxygen atoms, provided oxygen atoms are not bonded together directly;

A^{11} represents a 1,4-phenylene group, a 1,4-cyclohexylene group or a pyrimidine-2,5-diyl group, and said 1,4-phenylene group is either unsubstituted or is substituted with at least one fluorine atom or chlorine atom; and

X^{31} and X^{32} each independently represent a hydrogen atom, a fluorine atom, or a chlorine atom.

12. A chiral nematic liquid crystal composition according to claim 11, comprising at least one compound selected from a group consisting of compounds represented by general formula (III-a) and general formula (V-a):



wherein R^{35} , R^{36} , R^{37} and R^{38} each independently represent an alkyl group having 1 to 10 carbon atoms or an alkenyl group having 2 to 10 carbon atoms, and at least one methylene group within said alkyl group or said alkenyl group may be substituted with

either -CO- group, or with oxygen atom or -COO- group, provided oxygen atoms are not bonded together directly;

Z^{30} represents a single bond, or -CO-, -COO-, -OCO- or -CH₂CH₂-;

A^{12} represents a 1,4-phenylene group or a 1,4-cyclohexylene group, and said

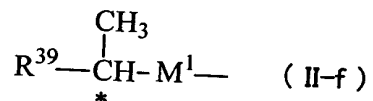
5 1,4-phenylene group is either unsubstituted or is substituted with at least one fluorine atom, chlorine atom or methyl group;

X^{33} , X^{34} , X^{35} and X^{36} each independently represent a hydrogen atom, a fluorine atom, a chlorine atom or a methyl group; and

p represents either 0 or 1.

10

13. A chiral nematic liquid crystal composition according to claim 12, wherein in general formula (II-d) and general formula (II-e), R^{31} and R^{33} are each represented, independently, by general formula (II-f):



15 wherein * represents a position of an asymmetric carbon atom; R^{39} represents an alkyl group having 1 to 6 carbon atoms or an alkenyl group having 2 to 6 carbon atoms;

M^1 represents a single bond or an alkylene group having 1 to 3 carbon atoms, and at least one methylene group within said alkylene group may be substituted with either -CO- group, or with oxygen atom or -COO- group, provided oxygen atoms are not bonded
20 together directly.

14. A chiral nematic liquid crystal composition according to claim 12, wherein in general formula (I-b), R^{30} represents an alkenyloxy group having 2 to 6 carbon atoms, and A^{10} represents a 1,4-phenylene group.

15. A chiral nematic liquid crystal composition according to claim 12, wherein the combined total amount of compounds represented by general formula (IV-a), general formula (III-a) and general formula (V-a) comprises 50 to 80% by weight of the composition.

16. A chiral nematic liquid crystal composition according to claim 12, wherein in general formula (III-a), a proportion of compounds in which said group R^{34} represents either an alkyl group having 2 to 3 carbon atoms or an alkenyl group having 2 to 3 carbon atoms comprises at least 70% by weight of all compounds represented by general formula (III-a).

17. A chiral nematic liquid crystal composition according to claim 1, wherein a natural pitch at 25°C is within a range from 0.1 to 3 μm , and a parameter ΔW_{0-50} is no more than 0.05, the parameter ΔW_{0-50} being defined by the formula below, and represents temperature dependency of wavelength selective reflection:

$$\Delta W_{0-50} = \left| \frac{2(\lambda_{50} - \lambda_0)}{\lambda_{50} + \lambda_0} \times \frac{100}{50} \right|$$

wherein λ_0 represents a wavelength selective reflection in nm at 0°C, and λ_{50} represents a wavelength selective reflection in nm at 50°C.

18. A bistable liquid crystal display element, which uses a chiral nematic liquid crystal composition according to claim 1.